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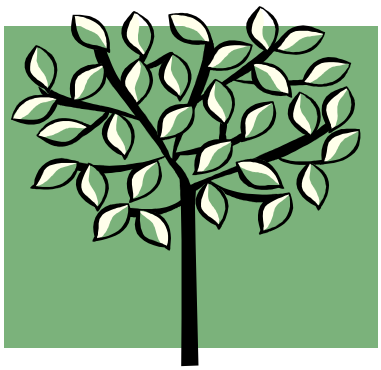
The Stand Manager

Technical Development, Planning and Utilization Unit Newsletter
NC Division of Forest Resources—DENR



Tech Updates

Ron Myers

What a difference a 1/2 year makes? One only has to examine how much money it costs to fill up the gas tank these days. During this same period, the costs of fertilizers has begun to moderate and fall as well. This issue contains tips on adapting management strategies to higher fertilization costs and how to determine when does it pay to fertilize? We also highlight some of the important progress and activities that our nursery staff has been doing with updates on tree improvement and genetic projects for several species that we manage. Utilization Forester Michael Mann gives us his perspective on woody biomass potential for energy in NC. In our Field Notes section, we provide a technology transfer summary of the USFS Shortleaf pine-bluestem ecosystem management and SILVAH, a computer application to help prescribe oak regeneration treatments for mixed-oak ecosystems.

The articles in the stand manager are designed to be brief while providing a concise overview or highlight of technical forest resource management information, research, projects, and activities. Feel free to contact the corresponding author for follow-up information.

Upcoming Workshop: 2009 Atlantic White-Cedar Symposium, June 9-11, Greenville, North Carolina

For more information and details go to http://www.ncsu.edu/feop/AWC/sysmposium

Inside this issue:

Conifer Silviculture

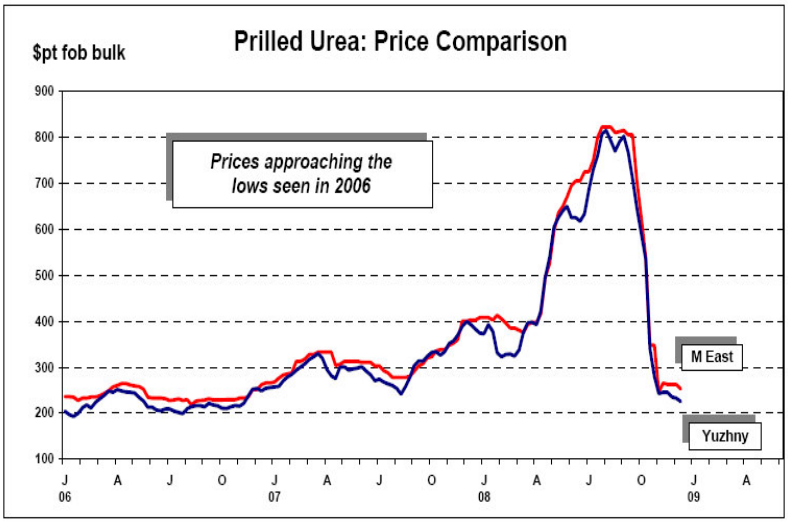
Bill Pickens

Adapting to Fluctuating Costs of Fertilizers and When Does it Pay to Fertilize?

Since January 2007, prices for urea and diammonium phosphate (DAP), popular forest fertilizers, have increased dramatically, quadrupling while peaking in August 2008. Currently, prices for urea have fallen back to the lows that were seen in 2006.

With the prospect of higher costs, the forest manager begins to question the benefit vs. the costs of certain treatments. **Does the volume gain from mid-rotation fertilization pay for the application costs?** Are there other ways I can increase stand volume yield and subsequent return on investment?

Why were prices so high in 2008? Fertilizer prices increased because of a worldwide increase in demand, and the price increase of natural gas at the time. There will always be market fluctuations based on worldwide economic changes and supply vs. demand issues.



Data Source: The Market Fertilizer News & Analysis (12/11/2008)

Conifer Silviculture Continued..

Nitrogen fertilizers require large amounts of natural gas to manufacture. Since the price of urea and ammonium nitrate are directly linked to the price of natural gas, expect fertilizer prices to continue to follow its market fluctuations. The price of phosphate fertilizers like diammonium phosphate (DAP) or triple super phosphate (TSP) are rising because of increased demand from China and India. Higher production of corn and soy bean crops in the US, and the use of phosphate by drug and food manufacturers contribute to increased demand.

How much gain can I expect from fertilization?

Numerous studies have demonstrated the effectiveness of mid-rotation fertilization to increase loblolly pine productivity. According to the Forest Nutrition Cooperative (FNC), **the mean response of loblolly pine to an application of 200 pounds of nitrogen and 25 pounds of phosphate is around 50 cubic feet/acre/year**, but higher and lower responses are possible.

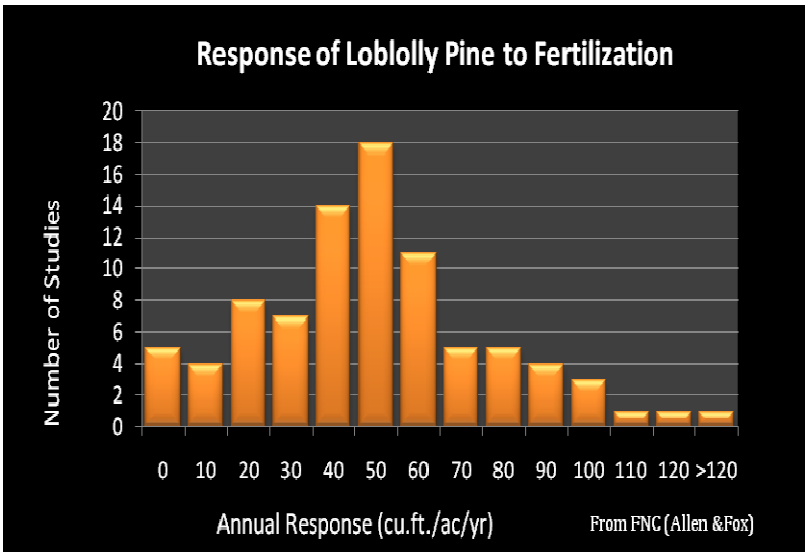


Figure 1 shows the range of annual response (cu.ft./ac/yr) of Loblolly Pine to fertilization for numerous studies. Data source provided by FNC.

When prices go higher does it pay to fertilizer?

Like so many forest economic questions, the answer is "It depends". How much return on investment (ROI) land managers can expect from fertilization can vary depending on site and economic factors. ROI can be influenced by rotation length, discount rates, market prices, and tax rates. Simple economics tell us that higher treatment costs can influence the expected rate of return. If we assume an average treatment response about 1.5 Tons/acre, and stumpage prices are at $25/ Ton, the ROI would be a 14.7 % for a treatment costing $100 per acre, but only 5.9% for a higher treatment cost of $190 per treatment. Note how much lower the return becomes if the treatment response is only 1 ton/acre/year.

Table 1 illustrates how rate of return varies with changing volume yields, stumpage prices, and treatment costs. **Data provided by the Forest Nutrition Cooperative (FNC).**

Treatment Response (T/ac/yr)	Stumpage Price $/Ton -- Treatment Cost $/acre									
	10		15		20		25		30	
	$100	$190	$100	$190	$100	$190	$100	$190	$100	$190
	ROI %									
0.5	-10.8	-17.7	-6.2	-13.4	-2.8	-10.2	0	-7.7	2.3	-5.6
1.0	-2.8	-10.2	2.3	-5.6	6.1	-2.1	9.1	0.6	11.6	3
1.5	2.3	-5.6	7.6	-0.7	11.6	3	14.7	5.9	17.4	8.3
2.0	6.1	-2.1	11.6	3	15.6	6.7	18.9	9.8	21.7	12.3
2.5	9.1	0.6	14.7	5.9	18.9	9.8	22.3	12.9	25.1	15.5
3.0	11.6	3	17.4	8.3	21.7	12.3	25.1	15.5	28	18.1
3.5	13.7	5	19.6	10.4	24	14.5	27.5	17.7	30.5	20.4
4.0	15.6	6.7	21.7	12.3	26.1	16.4	29.7	19.7	32.7	22.4

Adapting Management Regimes to Higher Fertilizer Costs

Fertilize stands with the potential for the greatest response or sites that are severely deficient in nutrients. Use leaf area index, soil type, foliar samples, and soil tests to carefully evaluate a stand or site to determine if the stand will adequately respond. Fertilize stands that meet a minimum criteria to capture the fullest gain. Consider delaying fertilization when prices trend higher or fertilize later in the stand rotation age. This delays costs and helps the bottom line. Fertilize with the appropriate nutrients. Some sites may need potassium or micro nutrients like boron, copper, magnesium to better utilize the added N or P.

Consider vegetative control. Good returns can be achieved from low treatment costs and good volume gains, especially for stands with hardwood BA >15 ft.^{2}/acre or with a dense evergreen shrub layer. Conduct a Thinning. Fertilize after thinning so that the response is captured by higher value wood products (chip-n-saw and sawtimber). Do not fertilize stands with a pulpwood management objective, unless the site is severely nutrient deficient.

Stand Criteria to Capture Full Gain

⇒ Young stands- 400 - 900 TPA. Stands 12-20 years old with 60-90 BA

⇒ Hardwood component < 15%

⇒ Foliar content N < 1.2 % Live crown length = 20 ft or 1/3 tree height

⇒ Prescribe burn 6 months prior or 1-3 year after fertilization

⇒ Thin stands > 120 BA prior to fertilization.

How can I determine if my stand needs fertilizer?

Many biotic factors contribute to the variability of fertilizer treatment response including, stand density, soil type, precipitation, drainage, live crown length, vegetative competition, and nutrient deficiencies. We can improve volume gain by following the minimum stand criteria listed. Leaf area and foliar analysis are two methods used to determine nutrient needs. The lower the Leaf Area Index the more likely fertilization will be beneficial. If the crown looks sparse, is flat topped, or chlorotic, its growth Is likely limited by nutrient deficiency or growing space. Foliar analysis helps identify deficiencies by providing information on what nutrients are not available or not able to be utilized by the tree.

Table 2. Critical values for foliar and soil nutrient content for loblolly pine.

		N	P	K	Ca	Mg	S	B	Cu
Foliar*	Loblolly	1.2	0.12	0.35	0.12	0.07	0.12	4-8 ppm	2-3 ppm
Soil (0-6 in.)			<3-5 ppm	<15ppm					

Additional fertilization information can be found at the following websites.

www.fertilizerworks.com/ -- for the latest market prices, www.bugwood.org/fertilization/ -- several publications and links.

www.forestnutrition.org/ -- leader of forest nutrition and forest productivity research

Fire Environment

Authors: Charles K. McMahon, Parshall B. Bush
USFS, G.W. Andrews Laboratory, Devall Drive Auburn University, AL

Forest Worker Exposure to Airborne Herbicide Residues in Smoke from Prescribed Fires in the Southern US

Below is the **Abstract** of an article that was published in American Industrial Hygiene Association Journal, Vol. 53, Issue 4, April 1992, pages 265-272

Occupational safety and health concerns have been raised in a number of southern states by workers conducting prescribed burns on forest lands treated with herbicides. Modeling assessments coupled with laboratory experiments have shown that the risk of airborne herbicide residues to workers is insignificant, even if the fire occurs immediately after herbicide application. However, no field studies had been conducted to confirm these findings. To bridge that gap, a field validation study was conducted in Georgia to measure the breathing zone concentrations of smoke suspended particulate matter (SPM), herbicide residues, and carbon monoxide (CO) on 14 operational prescribed fires. Smoke was monitored on sites treated with labeled rates of forestry herbicides containing the active ingredients imazapyr, triclopyr, hexazinone, and picloram. The sites were burned within 30-169 days after herbicide application. Tract size ranged from 2.4 to 154 hectares.

Fire Environment Continued..

Personal monitors and area monitors employing glass fiber filters and polyurethane foam collection media were used. **No herbicide residues were detected in the 140 smoke samples from the 14 fires conducted in this study.** The sensitivity of the monitoring methods was in the 0.1 to 4.0 µg/m^3 range, which is several hundred to several thousand times less than any established occupational exposure limit for herbicides. The smoke suspended particulate matter (SPM), and carbon monoxide (CO) monitored on these fires is the first time breathing zone concentrations of these smoke constituents have been measured in the South. As expected, concentrations were highly variable depending on fire conditions and the location of personnel. Worker respirable (2.3-µm particle cut point) SPM concentrations ranged between 0.2 and 3.7 mg/m^3.

Exposure periods depended on fire size and ranged from 1.2 to 6.3 hrs. Area monitors that were placed in high-density smoke zones had total SPM concentrations ranging between 2.0 and 45 mg/m^3. Carbon monoxide (CO) breathing zone concentrations ranged from <6 to 30 ppm/hr while the fires were being worked on. These values are well below the Occupational Safety and Health Administration (OSHA) permissible exposure limit of 35 ppm/hr when normalized to an 8-hr work shift.

McMahon, Charles K.; Bush, Parshall B. 1992. No herbicide residues found in smoke from prescribed fires. Management Bulletin R8-MB-56. Atlanta, GA: U.S. Department of Agriculture, Southern Region.

Nursery Tree Improvement & Genetics Updates

Ken Roeder, PhD. and Maxie Maynor

Loblolly Pine

Genetic Improvement of **Loblolly pine (*Pinus taeda*)** has made great strides over the past year. A limited amount of third cycle seed has been collected and is growing at Claridge Nursery this season. We expect to plant these seedlings at a few locations as demonstration plantings throughout the loblolly pine range in the state. More seed has been collected and more seedlings will be available next year. We will continue to look for host sites throughout Regions 1 & 2. Plans are also underway to conduct additional breeding to develop three **elite sawtimber populations** within the range of loblolly. This is being done in conjunction with the **North Carolina State University Tree Improvement Cooperative** for the *Northern, Piedmont* and *Coastal* loblolly pine breeding zones. North Carolina is in a unique position regarding these breeding zones considering significant areas of all three zones occur in North Carolina.

Third cycle loblolly pine growing at Claridge Nursery

NC DFR is planning to take genotypes in these newly identified elite sawtimber populations and breed them across these zones. This breeding will allow us to take some of the best individual performers in productivity, fusiform rust resistance and stem straightness from each zone and cross them to maximize gains. For instance, we will cross genotypes with the highest productivity with those genotypes with the best rust resistance, irrespective of breeding zone. The resulting seedlings will be tested for both traits combined. This ***North Carolina* elite sawtimber population** will result in greater total genetic gains in all three traits.

Longleaf Pine

NC DFR is continuing its work to make genetically improved **Longleaf pine (Pinus palustris)** available to NC residents. Seedlings produced at Claridge Nursery in Goldsboro come from seed collected from improved Longleaf pine seed orchards located at Bladen Lakes State Forest in Bladen County. These first generation orchards are managed for seed production and have been rogued based on field test results. This means that the best trees in the breeding program are crossing with each other to produce the best genetic combinations available for seedling production and field deployment. Seed is also collected from each mother tree in the seed orchards and kept separate from the other mother trees. This mother tree seed is then sown in the bare-root nursery beds and in containers as separate mother tree seedlots.

Updates Continued..

By keeping these family seedlots separate, more uniform family blocks can be planted. The additional uniformity in these single-family blocks simplifies management and may improve future stand performance. Trees come out of the grass stage closer to the same time and as a result compete with each other better. This results in a stand of more trees of the same approximate size and age. Faster growth and straighter trees are other traits that have been evaluated.

NC DFR Longleaf pine (14 feet tall @ 6 yrs) from Feb. 2001 planting. Photo taken in summer 2006.

As NC DFR continues with its genetic improvement work with Longleaf pine, more field tests are being added to expand the size of the genetically improved population and to make the next cycle of selections.

During the 2008 planting season, 2 new progeny tests were established. In the 2009 planting season, 3 additional progeny tests will be planted. At least one of these test sites will be in cooperation with the **Virginia Department of Forestry**. Plans are underway to include any new selections coming from these tests into the next cycle of seed orchard production. However, as recent advances in Forest Genetics suggest, new techniques may be available to speed the deployment of this next cycle of improvement.

Additional sites are needed to install more genetic tests. The nursery is looking for a 4-5 acre old field site that is fairly uniform and has good potential for growing longleaf pine. If your county has active landowners that would like to participate, contact the Nursery & Tree Improvement staff at Goldsboro Forestry Center.

Fraser Fir

A limited amount of second generation seed from the genetically improved Fraser fir seed orchards was collected in 2008. Several of these seedlots were collected in sufficient quantities to be sown in the new greenhouse during the spring of 2009 and will be available commercially from that year's seedling crop. Those second generation seedlots producing only a limited amount of seed will be greenhouse sown for progeny testing. These progeny tests will be used to make our first, 3rd generation selections.

Cooperative work with the US Forest Service—NC DFR collected seed from an untested USFS Eastern **White pine (*Pinus strobus*)** seed orchard in August 2008. Seed from more than sixty families were collected. Seedlots of individual families will be grown for progeny testing. These seedlots will be tested for timber production and for use as Christmas trees. The **Tennessee Division of Forestry** will also install a companion progeny test. The USFS is also sharing family seedlots from their **White Oak (*Quercus alba*)** in Murphy, NC. These seedlots will be sown for progeny testing. The USFS has supplied **Shortleaf pine (*Pinus echinata*)** seed for progeny testing. Many of the original Shortleaf pine selections that were made in the past have died or are too old for successful grafting. The seed from USFS will allow NC DFR to revitalize its Shortleaf pine breeding program and make new selections based on disease resistance and volume production.

Ranger Training in the Fall at Crossnore. Level I Class on Left with Instructors and Level II Class on Right

Forest Utilization & Markets

Michael Mann

"A Forester's Perspective on Woody Biomass Potential for Energy in North Carolina"

This fall, two woody biomass energy workshops were conducted in Winston-Salem and Kinston. The workshops were sponsored by North Carolina State University's Forest and Environmental Outreach Program (FEOP) with cooperation from NC DFR.

Understory stems thinned & removed by a whole tree chipping operation in Nash County

The workshops focused on a discussion of the types of biomass fuels being used and who is using them. They also focused on providing estimates of how much woody biomass can be produced sustainably and potential sources, biomass incentives and legislation, the role of dedicated wood energy crops, harvesting systems, environmental issues, and the role of field practitioners such as loggers and foresters in helping to develop wood-based energy as a sustainable forest products industry.

Michael Mann, Utilization Forester with NC DFR provided an update of the current usage of woody biomass as a fuel in North Carolina. According to data presented by Mann, wood and wood waste in NC is currently being burned directly as either boiler fuel or the wood is gasified and used as a biomass gas. Black liquor, a byproduct of the pulping process at pulp mills, is also converted to a biomass gas and burned for energy. Wood and wood waste can also be processed into biodiesel or ethanol but this is not currently being done in North Carolina at any commercial scale.

There are currently about **200 facilities scattered across the state that consume approximately 5.1 million tons of woody biomass for energy.** The piedmont has the most facilities, but the northern coastal plain with two pulp and paper mills, uses the most biomass on a tonnage basis. **About 71 percent of the facilities that consume wood for energy are primary forest product industries such as sawmills, pulp and paper mills, veneer and plywood mills, etc. The remaining 29 percent include a broad array of industries including energy producers, secondary wood products manufacturers, and agricultural industries such as Corn Products International in Winston-Salem.** New demand will result from either the construction of new facilities that are outfitted to burn woody biomass or from the conversion of existing coal or fuel oil facilities to wood biomass using facilities. Fourteen projects were identified and discussed. Four of the projects were out-of-state projects that would utilize biomass from North Carolina. **In total, the fourteen projects if completed, will consume an additional 5.2 million tons per year of woody biomass by the year 2012.**

Field Notes:

NC DFR Silviculturists Bill Pickens and Ron Myers recently attended the 15th Biennial Southern Silvicultural Research Conference that was held in Hot Springs, Arkansas. This conference highlights professional presentations on the latest silvicultural research studies, treatments, and management prescriptions that are being conducted in our southern forests. The highlight of the trip was a field tour to the Ouachita National Forest led by Project Leader Dr. James Guldin with the USFS Southern Pine Ecology & Management Research Work Unit. The objective of the tour was to illustrate silvicultural practices used to restore the shortleaf pine-bluestem grass ecosystem and the recovery of Red-cockaded woodpeckers on the Ouachita NF.

These restored stands reflect conditions that were widespread prior to the harvest of the virgin forests in the early 1900's, but are now under-represented on the landscape today. Within this shortleaf pine-bluestem grass ecosystem, some of the elements of ecosystem management include increasing the use of prescribed fire and using tree cutting to simulate natural disturbance patterns, increasing rotation ages, developing and maintaining forested linkages among mature forest habitats, and maintaining mixtures of native pines and hardwoods.

The USFS has been successfully implementing a silvicultural prescription to overstocked stands with desirable shortleaf pine stems. The first step is to reduce the basal area by thinning pine stands down to 60 ft^2/acre with a target of between 60-75 Residual square feet/acre. Harvesting is conducted with attention to what is retained, leaving primarily sawtimber sized trees for long rotations. After the initial harvesting period, a mid-story and co-dominant tree removal treatment is conducted to reduce smaller, undesirable, stems under the pine overstory. They call this treatment a Wildlife Stand Improvement (WSI) treatment since they are not solely focused on timber quality or production. Not all hardwood trees are removed and approximately 10-20 ft^2/acre is left for long term mast production. The last step is to initiate a 3 year cycle of prescribed burning during the dormant season.

Shortleaf pine-bluestem ecosystem thinned and burned

The open midstory following treatment creates a brief window of suitable habitat for some pine-grassland bird species. By the third post-burn season, woody shrubs dominant the understory and the cycle must begin anew. Several researchers have found that mature shortleaf pine-bluestem stands with abundant herbaceous ground cover and little to no hardwood midstory, managed with late-dormant season fire at 3 year intervals, show a dramatic increases in both richness and density of small mammals and songbirds (Masters and others 2001, 2007). Additional references include the following:

Masters, R.E; Wilson, C.W.;Cram, D.S.; Bukenhofer, G.A. 2001. Reintroduction of fire benefits breeding birds in pine-grasslands (Arkansas). Ecological Restoration. 19(4):265-266.

Masters, R.E. 2007. The importance of shortleaf pine for wildlife and diversity in mixed oak-pine forests and in pine-grassland woodlands. In: Kabrick, J.M.; Dey, D.C.; Gwaze, D., eds. Shortleaf pine restoration and ecology in the Ozarks: proceedings of a symposium; 2006 November 7-9. USDA Gen. Tech. Rep. NRS-P-15., NRS: 35-46

Hardwood Silviculturist Ron Myers attended an Oak Silvah Workshop in Brookville PA in September 2008. The workshop focused on the Ecology and Silviculture of Mixed Oak Forests and using the SILVAH computer program. It was originally developed for the Allegheny hardwoods but in 2000, SILVAH expanded to include mixed oak forests.

Shelterwood stand with competitive oak in foreground

The most recent version of SILVAH 5.6 is available for free download from the USFS Northern Research Station website. The SILVAH decision support system can recommend appropriate silvicultural treatments based upon user objectives, overstory plot data, understory plot data, and site data provided by the user. This computer program is very easy to use, you can customize user fields to include local price data and merchantability standards, and can generate reports to include in any management plans.

This program will summarize plot data from both overstory & understory plots, and provide information on regeneration, factors affecting regeneration difficulty, information on wildlife habitat, and stand summary information by species composition, basal area, tree quality, product classes, volumes, and marking instructions for shelterwood applications. This program can be a useful tool for forest managers wanting to conduct alternative harvest methods in mixed-oak ecosystems. The summary reports alone are beneficial to adequately assess the regeneration potential of the stand prior to harvest and to provide marking guidelines by species and size classes in order to retain acceptable growing stock for future management.

A free copy of SILVAH can be downloaded at http://nrs.fs.fed.us/tools/silvah

Bose, P. H. and others. 2008. Prescribing regeneration treatments for mixed-oak forests in the Mid-Atlantic region. Gen. Tech. Rep. NRS-33. USDA USFS, NRS. 100p.

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